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SUPPRESSION OF WESTERN SPRUCE BUDWORM INFESTATIONS
IN HIGH-USE RECREATIONAL CAMPGROUNDS WITH
BACILLUS THURINGIENSIS
AND ACECAP 97 SYSTEMIC TREE IMPLANTS

Carson National Forest
New Mexico
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Carson National Forest
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ABSTRACT

During June 1985, eleven high-use recreational campgrounds on the Carson National Forest were ground sprayed with the biological pesticide Bacillus thuringiensis. Fifty trees in two campgrounds were also treated with Acecap 97 systemic tree implants (active ingredient--acephate). Overall, ground spray treatments were effective in reducing western spruce budworm larval populations to low levels (1 or fewer larvae per 100 buds) and also provided good to excellent foliage protection in most campgrounds. Foliage protected by ground spray treatments ranged from 15.4 to 87.4 percent.

The Acecap 97 systemic insecticide treatments provided excellent foliage protection to all individual high-value trees treated. Percent foliage protected averaged 87 percent or better. However, because a certain amount of wound damage is incurred by the tree during treatment, the use of these systemic insecticide implants is only recommended when ground spray insecticide treatments will not effectively achieve management objectives.

INTRODUCTION

In 1985, eleven high-use recreational campgrounds on the Carson National Forest (CNF) infested with the western spruce budworm (WSB), Choristoneura occidentalis Free., were ground sprayed with the biological insecticide Bacillus thuringiensis (B.t.). Fifty trees in two campgrounds were also treated with Acecap 97 systemic insecticide tree implants. Most of the trees in these high-use recreation areas have been moderately to heavily defoliated by the WSB for up to 5 or more years.

This report describes the location of the high-use recreational campgrounds treated with insecticides in 1985, the insecticides applied, application procedures, sampling techniques and results of treatments.

OBJECTIVE

The objective of these insecticide treatments was to prevent further deterioration of visual quality in selected high-use recreational campgrounds on the Questa and Taos Ranger Districts (RD) by protecting new foliage growth on individual high value trees from WSB larval defoliation.

PROJECT AREA AND ADMINISTRATION

The project area consisted of eleven campgrounds which ranged from 0.5 to 5 acres in size. These campgrounds were located in Red River (5) and Hondo (4) Canyons, Questa RD (Figure 1) and Taos Canyon (2), Taos RD (Figure 2). Estimated numbers of trees and acres ground sprayed are summarized in Table 1. This project was administered and supervised by personnel from the CNF with the assistance of Forest Pest Management, Southwestern Region.

TIMING OF INSECTICIDE APPLICATIONS

Timing of the ground spray B.t. insecticide treatments was based primarily on bud development. Ground spraying commenced when current year's buds were 80 to 90 percent flushed and foliage partially extended. Monitoring of bud development was initiated on May 22, 1985. All areas ground sprayed were examined once a week until buds were sufficiently flushed and extended. Larval development at time of treatment was primarily in the 2nd, 3rd, and early 4th instars. These data are summarized in Table 2.

Acecap-97 systemic insecticide treatments were initiated when host tree buds began to show signs of development (swelling) and prior to 2nd instar budworm attack. Timing of treatments is critical since it takes approximately 20 days for a lethal dose of the active ingredient--acephate to be translocated from the implantation site to the foliage (Reardon, 1984).

INSECTICIDES

Dipel 4L is a commercial formulation of spores and crystalline bodies produced by the bacterium B.t. To be effective, B.t. must be ingested by the WSB. Once ingested, a toxin is released that paralyzes the gut wall. Feeding may stop within 30 minutes to 2 hours and death usually follows in 3 to 5 days. B.t. is highly specific, affecting only the larval stage of certain species of moths and butterflies. B.t. is sensitive to ultraviolet light and has a very short residual life.

Acecap 97 systemic tree implants are tubular plastic cartridges, 0.4 by 1 inch (1 by 2.5 cm) containing a concentrated form of the organophosphate insecticide acephate (Orthene). Acephate is an insecticide of moderate persistence and is primarily a contact and stomach poison. Acecap 97 cartridges contain 0.03 ounces (0.9g) active ingredient of acephate. This insecticide is eventually broken down within the tree.

INSECTICIDE APPLICATIONS

B.t. was applied at 16 billion international units per 100 gallons of water along with 2 ounces of sticker (Plyac) to improve rain-fastness. Individual trees were sprayed (Figure 3) using a high pressure hydraulic sprayer operated at 400 to 450 pounds pressure per square inch (PSI) equipped with an adjustable variable spray nozzle. All trees were sprayed to the point of runoff.

Acecap 97 cartridges were implanted by drilling a three-eighth inch diameter hole through the bark 1.5 inches deep into the sapwood. The cartridges were driven to the bottom of the hole leaving the outer end approximately 1 inch below the bark surface. The cartridges were implanted at about 4 inch (10 cm) intervals near the base of the trunk, 6 to 18 inches (15 to 45 cm) above the ground, preferably in the root-flare area (Figure 4).

SAMPLING DESIGN

Larval Sampling--Twenty-four hours prior to ground spray treatments, WSB population densities were sampled to determine larval densities per 100 buds. Two 45 cm branch tips were cut from opposite sides of the midcrown from each of 5 sample trees in each campground using a pole pruner with attached collecting bag. Every sample branch had to have at least 6 live buds. The contents of collecting bag and branch were then shaken onto a drop cloth. All budworm larvae were tallied and then preserved in alcohol.

Postspray larval densities were sampled 21 days following treatment. The same field procedures used for sampling prespray budworm larval population densities were used to sample postspray larval densities. Budworm pupae, if present, were counted as surviving larvae.

Larval mortality was expressed as the percentage reduction in the population between prespray and postspray larval densities. Percent mortality (percent reduction) in budworm populations was calculated as follows:

Percent Mortality Unadjusted =

$$(1 - \frac{\text{Postspray}}{\text{Prespray}}) \times 100$$

WSB larval population densities were not sampled on trees treated with Acecap 97 systemic tree implants since these trees were treated prior to 2nd instar budworm attack.

Foliage Protection--In late August and early September, all areas ground treated with insecticides were sampled to determine percent defoliation caused by the WSB. Forty-five trees ground sprayed with B.t. (5 per campground) and 22 trees (12 in June Bug Campground and 10 in Elephant Rock Campground) treated with Acecap 97 systemic tree implants were sampled. Defoliation was estimated by examining 25 new shoots on each of the 2 branches per sample tree. Each shoot was individually examined and assigned an index value based on the 6-Class System:

<u>Rating</u>	<u>Percent Defoliation</u>
0	0
1	>0 - 25
2	26 - 50
3	51 - 75
4	76 - <100
5	100

Defoliation was analyzed on a per tree basis and averaged per campground. The following formulas were used to determine percent defoliation:

At the branch level:

$$\overline{\text{DEF}}_{i,j,k} = \frac{[N_0 (0) + N_1 (12.5) + N_2 (37.5) + N_3 (62.5) + N_4 (87.5) + N_5 (100)]}{[N_0 + N_1 + N_2 + N_3 + N_4 + N_5]}$$

At the tree level:

$$\overline{\text{DEF}}_{i,j} = \sum_{k=1}^2 \text{DEF}_{i,j,k} / 2$$

At the cluster level:

$$\overline{\text{DEF}}_i = \sum_{j=1}^5 \text{DEF}_{i,j}/5$$

Where : i= cluster i= 1
 j= trees¹ j= 5
 k= branches k= 2

Defoliation estimates were also obtained from nearby untreated areas located in Taos, Hondo, and Cabresto Canyons. These defoliation estimates were then used to estimate percent foliage protection achieved within the treated areas. Percent foliage protection was determined using the following formula:

Percent foliage protected =

$$(1 - \frac{\text{percent defoliation in treated areas}}{\text{percent defoliation in untreated areas}}) \times 100$$

RESULTS AND DISCUSSION

Larval Densities--Average prespray and postspray larval population densities monitored in campgrounds treated with ground spray applications of B.t. are summarized in Table 3. These data show that B.t. ground spray treatments were effective in reducing WSB larval population densities on individual high value trees to low levels. Average pretreatment larval population densities which ranged from 4.0 to 27.5 larvae per 100 buds were reduced to 1 or fewer larvae per 100 buds 21 days after treatment. Percent mortality (unadjusted for natural mortality) ranged from 90 to 100 percent.

Foliage protection--WSB-caused defoliation to new foliage growth in 1985 in high-use recreation campgrounds treated with B.t. averaged less than 35 percent (Table 4). Average defoliation, which was lowest in Capulin, Cuchilla, Fawn Lakes, Elephant Rock, and June Bug Campgrounds, ranged from 8.5 to 32.6 percent. Budworm infestations in these campgrounds were sprayed soon after bud flush and when budworm larval development was primarily in the 2nd, 3rd, and early 4th instars. Foliage protected by B.t. ground spray treatments in these campgrounds averaged from 50.5 to 87.4 percent (Table 4).

Ground spray treatments were less successful in La Sombra and Goat Hill Campgrounds where treatments were delayed up to a week because of differences in rates of foliage bud development and in Columbine Campground where poor weather conditions (rain showers) occurred shortly after treatment. Defoliation to current years foliage growth in these campgrounds was moderate, averaging 44.1, 55.0, and 52.6 percent respectively. Overall foliage

¹ j = 12 trees for Acecap treatments in June Bug Campground.
j = 10 trees for Acecap treatments in Elephant Rock Campground.

protection in these campgrounds was considered low averaging less than 25 percent of the current year's foliage growth (Table 4).

Defoliation estimates on individual high-value trees treated with the Acecap systemic tree implants averaged less than 10 percent of the current year's foliage growth. Percent foliage protected by treatments ranged from 87.1 to 97.1. These data are summarized in Table 5.

CONCLUSIONS

Ground spray treatments with B.t. (applied at 16 BIUs per 100 gallons of water) effectively reduced WSB larval populations to low levels (1 or fewer larvae per 100 buds) in all high-use recreational campgrounds treated in 1985. WSB-caused defoliation in most campgrounds averaged less than 35 percent of the current year's foliage growth. Overall, foliage protected by ground spray treatments was considered good to excellent and ranged from 50.5 to 87.4 percent. However, in campgrounds where treatments were delayed (La Sombra and Goat Hill) or where poor weather conditions occurred shortly after treatment (Columbine) foliage protection was less successful averaging less than 25 percent.

Acecap 97 systemic insecticide treatments provided excellent protection against WSB-caused defoliation. Individual high-value trees treated with this insecticide averaged less than 10 percent defoliation to current year's foliage growth. Percent foliage protected ranged from 87.1 to 97.1 percent. However, because there is a certain amount of tree wounding incurred by the use of systemic insecticide treatments, their use is only recommended when ground spray insecticide treatments will not effectively achieve management objectives.

To prevent unacceptable levels of defoliation in high value areas, timing of insecticide applications is critical. For maximum effectiveness in preventing WSB-caused defoliation, ground spray treatments should commence shortly after bud flush and when larval development is primarily in the 2nd, 3rd, and early 4th instars. If individual high value trees are treated with Acecap 97 systemic tree implants, trees should be implanted immediately after foliage buds begin to show signs of development (swelling). In northern New Mexico this usually occurs sometime during the last week of April and/or the first week of May.

LITERATURE CITED

- Reardon, Richard C. 1984. How to protect individual trees from western spruce budworm defoliation by implants and injections USDA FS Agriculture Handbook No. 625, 15 pp.

Table 1--Estimated number of trees and acres ground sprayed with B.t. per campground, CNF, 1985.

CAMPGROUND	TREES SPRAYED		ACRES SPRAYED	DATE TREATED
	>6" dbh	<6" DBH		
Taos Canyon				
• Capulin	150	200	5.0	6/8-9
La Sombra	125	200	3.5	6/11
Hondo Canyon				
Lower Hondo	70	70	2.0	6/8
Cuchillo	160	125	5.0	6/10
Italianos	30	20	0.5	6/10
Red River Canyon				
Goat Hill	30	60	2.0	6/11
Columbine	190	400	4.0	6/12-13
Fawn Lakes	530	800	5.0	6/11-12
Elephant Rock	165	50	2.5	6/13
June Bug	170	100	3.0	6/14

Table 2--Percent WSB larval development by instar at time of treatment in campgrounds ground spray with B.t., CNF, 1985.

CAMPGROUND	LARVAL INSTARS					PUPAE	DATE SAMPLED
	II	III	IV	V	VI		
Taos Canyon							
Capulin	0	30	70	0	0	0	6/6/85
La Sombra	0	6	65	29	0	0	6/6/85
Hondo Canyon							
Lower Hondo	0	33	47	16	4	0	6/6/85
Cuchilla	0	0	100	0	0	0	6/6/85
Italianos	NO DATA COLLECTED						
Red River Canyon							
Goat Hill	0	30	56	12	2	0	6/7/85
Columbine	18	42	38	2	0	0	6/7/85
• Fawn Lakes	4	45	51	0	0	0	6/7/85
Elephant Rock	8	60	30	2	0	0	6/7/85
June Bug	NO DATA COLLECTED						

Table 3--Average pre- and postspray larval densities per 100 buds and percent unadjusted mortality in high use recreational campgrounds treated with B.t., CNF, 1985.

CAMPGROUND	N	PRESpray LARVAE PER 100 BUDS	POSTSPRAY LARVAE PER 100 BUDS	UNADJUSTED PERCENT MORTALITY
Taos Canyon ¹				
Capulin ¹	5	11.7	0.7	94
La Sombra	5	4.0	0.4	90
Hondo Canyon				
Lower Hondo ¹	5	15.4	00	100
Cuchilla ^{1,2}	5	4.6	0.3	93
Italianos	NO DATA COLLECTED			
Red River Canyon				
Goat Hill	5	27.5	0.6	98
Columbine	5	26.1	0.5	98
Fawn Lakes	5	11.5	0.4	97
Elephant Rock	5	10.5	1.0	90
June Bug	NO DATA COLLECTED			

¹ Sample trees in these campgrounds consisted of white fir.

² Cuchilla and Upper Cuchilla Campgrounds were combined.

Table 4--Average percent defoliation and percent foliage protected in high use recreational campgrounds treated with B.t., CNF, 1985.

CAMPGROUND	N	AVERAGE PERCENT DEFOLIATION	PERCENT FOLIAGE PROTECTED
Taos Canyon ¹			
Capulin	5	11.1 ± 1.5	78.7
La Sombra	5	44.1 ± 12.2	15.4
Check	9	52.1 ± 3.5	
Hondo Canyon			
Lower Hondo ¹	5	32.6 ± 11.0	50.5
Cuchilla ¹	5	12.0 ± 3.0	81.8
Italianos	NO DATA		
Check	15	65.9 ± 5.6	
Red River Canyon			
Goat Hill	5	55.0 ± 11.3	18.6
Columbine	5	52.6 ± 12.6	22.2
Fawn Lakes	5	26.3 ± 3.6	61.1
Elephant Rock	5	27.3 ± 9.4	59.6
June Bug	5	8.5 ± 2.3	87.4
Check	12	67.6 ± 4.0	

¹Trees sampled consisted of white fir.

Table 5--Average percent defoliation on trees treated with systemic insecticides (Acecap 97), CNF, 1985.

CAMPGROUND	N	AVERAGE PERCENT DEFOLIATION	PERCENT FOLIAGE PROTECTED
June Bug	12	1.8 ± 0.3	97.1
Elephant Rock	10	8.0 ± 1.2	87.1
Check	10	62.0 ± 7.9	

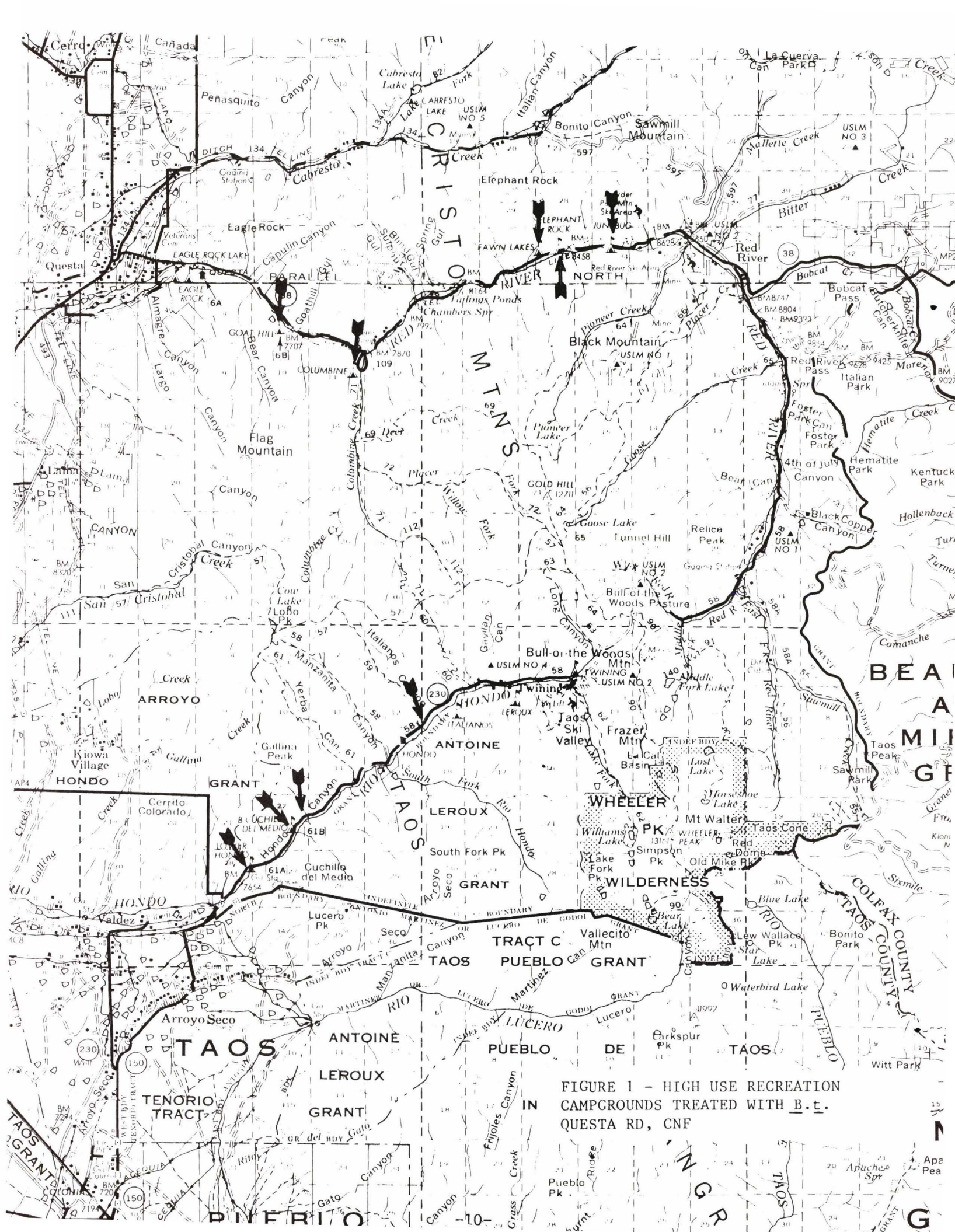


FIGURE 1 - HIGH USE RECREATION CAMPGROUNDS TREATED WITH B.t. QUESTA RD, CNF

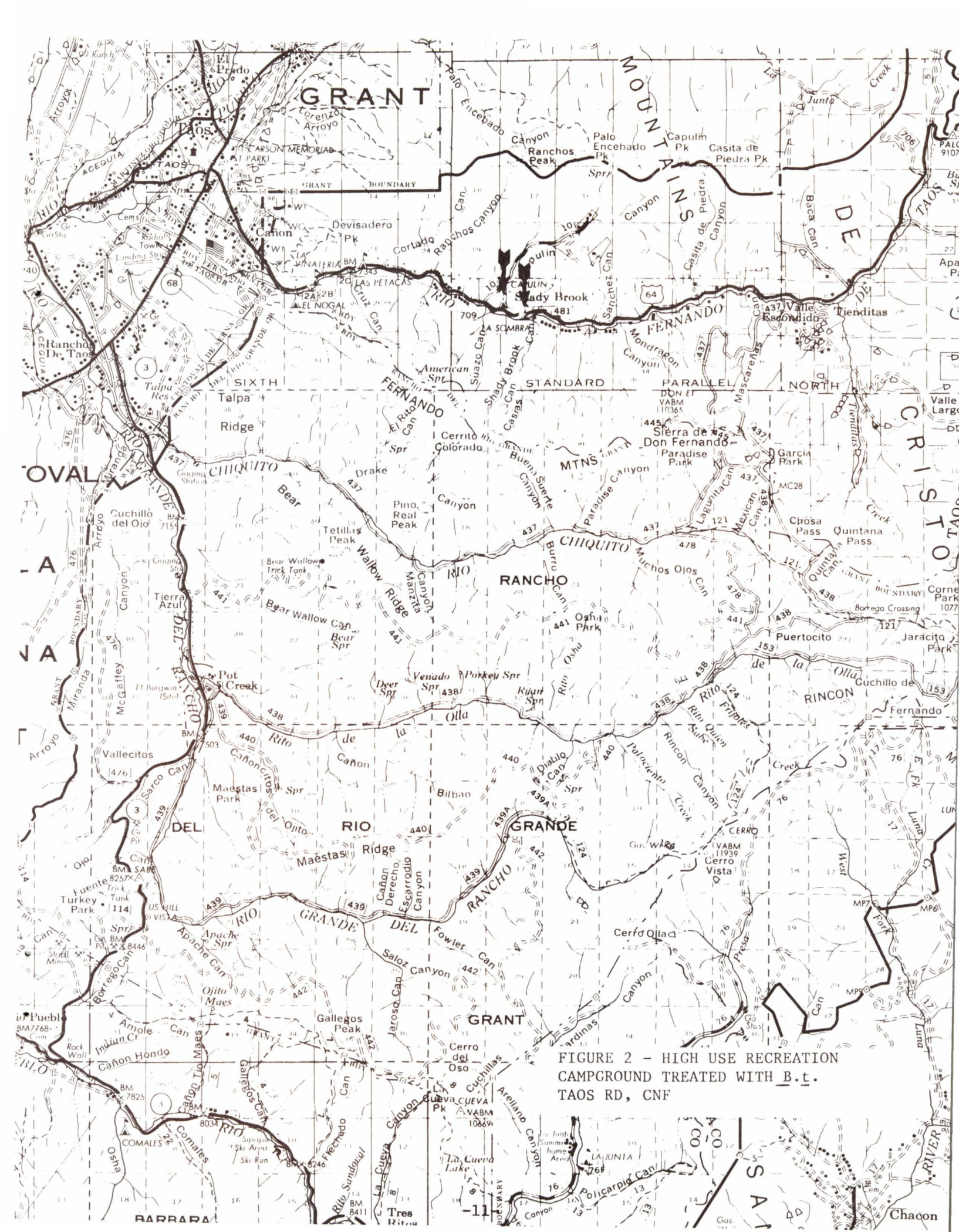


FIGURE 2 - HIGH USE RECREATION
CAMPGROUND TREATED WITH B.t.
TAOS RD, CNF



Figure 3--Individual trees in high value campgrounds being ground sprayed with B.t.

Figure 4--Acecaps implanted at 4 inch intervals (10 cm) near base of tree trunk.

